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LISTS OF SPECIES

Anurans from the "Restinga" of Parque Natural Municipal de Grumari, state of Rio de Janeiro, southeastern Brazil

Felipe Bottona da Silva Telles*, Vanderlaine Amaral Menezes, Thiago Maia-Carneiro, Thiago Arnt Dorigo, Gisele Regina Winck and Carlos Frederico Duarte Rocha

Universidade do Estado do Rio de Janeiro, Instituto de Biologia Roberto Alcântara Gomes, Departamento de Ecologia, Programa de Pós-Graduação em Ecologia e Evolução. Rua São Francisco Xavier 524, pavilhão Haroldo Lisboa, sala 220. CEP 20550-019. Rio de Janeiro, RJ, Brazil.
* Corresponding author. E-mail: *felipebottona@uerj.br*

ABSTRACT: We present a list of the anuran amphibians from "restinga" of Grumari, part of the Parque Natural Municipal de Grumari (PNMG), Rio de Janeiro municipality, state of Rio de Janeiro, southeastern Brazil. This study was carried out from May 2009 to December 2010 using two active sampling methods: quadrant plots and acoustic/visual transects. We recorded 22 anuran species distributed in six families: Bufonidae (1 species), Craugastoridae (1), Hylidae (14), Leptodactylidae (3), Microhylidae (2) and Strabomantidae (1). The presence of endangered and endemic species evidence Grumari's importance as an area for conservation of the "restinga" habitat remnants in Rio de Janeiro. Grumari is also one of the richest known areas in terms of amphibian species among the "restinga" areas studied to date in Brazil, second only to Mata de São João, Bahia.

INTRODUCTION

"Restingas" constitute one of the coastal habitats associated to the Atlantic Rainforest Domain. These environments are characterized by xerophitic vegetation; nutrient-poor sandy soils; high temperatures; low availability of free water and high salinity (Scarano 2002). Flora and habitat structure, within the vegetation zones distributed from the sea line to inward, differ markedly between restingas along the coastline (Araújo *et al*. 1998). Restingas are one of the most threatened ecosystems in Brazilian territory, being critically exploited for centuries since the arrival of colonizers on the coast to present. These habitats are under intense set of pressures as result of a demographic density five times higher than the country's average (MMA/SBF 2002), leading to occupation and eventual loss of such habitats by vegetation clearings. This is especially alarming for threatened and/or endemic populations of terrestrial vertebrates (Rocha *et al.* 2007), which lose potential microhabitats restricting even more their distribution, fact that is compounded by the difficulty of vegetation recovery after clearings (Rocha *et al.* 2005). Presently, restinga remnants along much of eastern Brazilian coast are composed by isolated fragments (Rocha *et al.* 2003).

Although restinga habitats represent approximately 5000 km of the 9200 km of Brazilian coastal extension (Lacerda *et al.* 1984), information available about the composition of anuran fauna present on those habitats are restricted to relatively few areas (*e.g.* Van Sluys *et al.* 2004; Bastazini *et al.* 2007; Silva *et al*. 2008). Usually, much of the sampling efforts are spent on reproductive sites such as ponds (Narvaes *et al.* 2009), and on bromeligenous/bromelicolous species (Peixoto 1995; Schineider and Teixeira 2001; Teixeira *et al.* 2002; Mesquita *et al.* 2004), with less standardized effort to sample different vegetation zones of restingas.

The restinga area of the Parque Natural Municipal de Grumari (PNMG), although inserted within the limits of a large city (Rio de Janeiro), lacks information on most faunal groups, including amphibians. The only study providing any information regarding amphibians from this area was that of Rocha *et al.* (2008), but in this study the restinga of Grumari was surveyed for an extremely short time period (two nights). Aware of this, we provide a more extensive list of amphibian species from the restinga area of PNMG, in the state of Rio de Janeiro.

MATERIALS AND METHODS

Study area

Sampling was carried out in a restinga habitat with an area of ca. 95 ha (23°02' S, 43°32' W) at the PNMG (Figure 1). There are 222 plant species recorded for the restinga of Grumari, with 49 species in the municipal list of endangered species. Some of the more representative plant families in the area are Leguminosae, Myrtaceae, Orchidaceae, Bromeliaceae and Rubiaceae (Pereira and Araújo 2000). Rocha *et al.* (2004a) recorded 14 bromeliads species in restinga of Grumari, one of the richest areas in terms of bromeliads among the 15 areas studied by them. The climate in the municipality of Rio de Janeiro is hot and humid, with mean annual temperature, rainfall and relative humidity of 23.7°C, 1172.9 mm and 79% respectively, according to data from the Instituto Nacional de Metereologia (DNMET 1992), spanning the period between 1973 and 1990.

Sampling methods

We surveyed the area for frogs in different environments, such as herbaceous-shrubby and arboreal vegetation zones of the restinga of Grumari and a large lagoon present in the area. For this we used two sampling methods: plot sampling (or quadrats; according to Jaeger and Inger 1994) and active search (Crump and Scott 1994). For plot method, samples were taken in the dry

(May to September 2009) and rainy seasons (January and December 2010). We established randomly 160 quadrats of 4 x 4 m (16 m^2) on the forest floor, totaling 2560 m^2 of leaf litter sampled. For the establishment of plots, we marked the corners of each plot during afternoon with wooden stakes and the area inside was enclosed with a 50 cm high soft plastic fence, whose base was buried and/or attached to the ground (Jaeger and Inger 1994). Fifteen minutes after sunset (given by a GPS Garmin Etrex®) each quadrat was carefully searched, for floor-dwelling anurans, for about 20 minutes (on average) by four people using headlamps and moving on hands and knees, side-by-side. During the search, leaves, branches, and stones were overturned with the aid of hand rakes, and mesh of dry roots underneath the leaf litter layer and fissures among tree roots were also checked.

On January 2010 we performed active searches using transect sampling constrained by time (30 minutes) and space (32 m), totaling a sampled area of 1152 m^2 (384 m x 3 m) and a total time of 360 minutes in transect sampling (120 min/man) with acoustic and visual searches. Transect sampling started at 18:00 h and the observers searched every potential microhabitat available recording all individual anurans sighted within 1.5 m to each side of the observer. Frogs sighted were captured and maintained in plastic bags until all transects ended in one night. The areas sampled were not repeated, avoiding the register of the same individual more than once. Occasional visual encounters of amphibians outside of plot and transect samplings were also recorded. The microhabitat used by each individual found was registered in the field at the moment of its first sighting and classified according to the following categories: 1) Leaf litter (Lt); 2) Bromeliads (Br); 3) Trees/Bushes (Tr); 4) Vegetation on water (Vw); 5) Edge of pond (Ep); 6) Swamp (Sp).

Voucher specimens were collected (Municipal Permit Number: 17/2008) and killed with Lidocaine gel at 5% on their skin, immediately fixed in 10% formalin and preserved in ethanol 70%. Specimens are housed in the amphibian collection of Museu Nacional, Universidade Federal do Rio de Janeiro (MNRJ), Rio de Janeiro, Brazil (Appendix 1). The taxonomy applied followed Frost (2011).

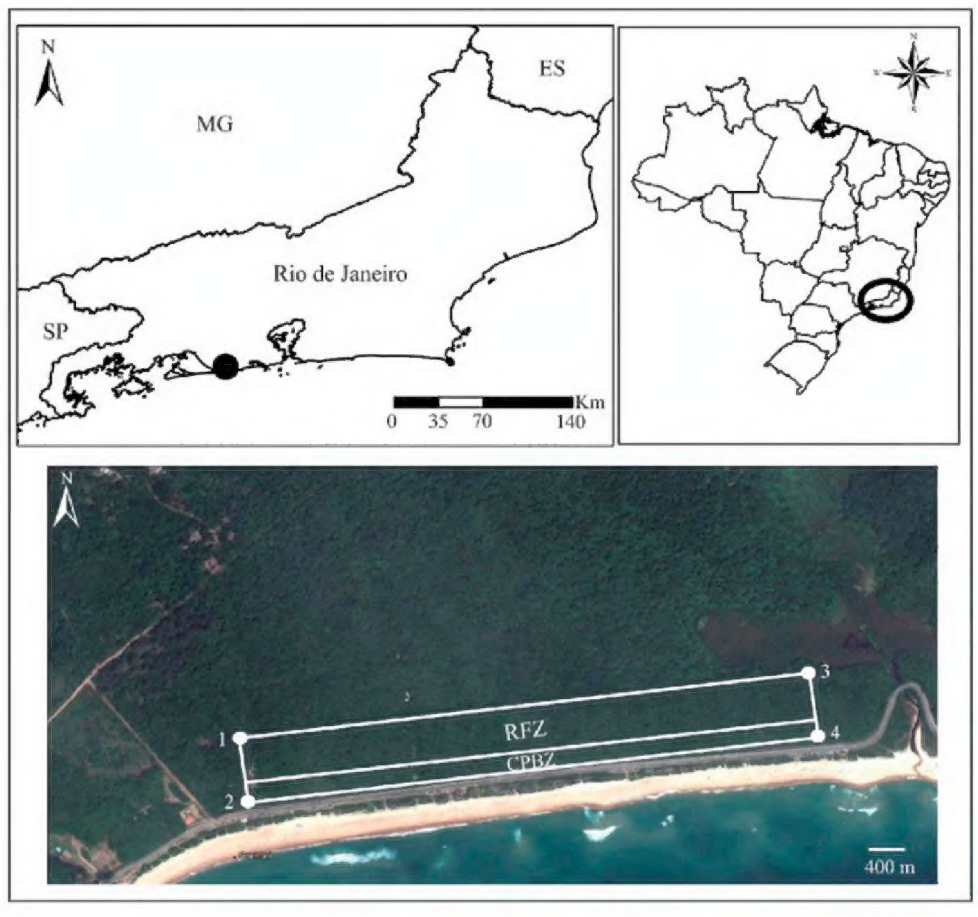

Figure 1. View of the vegetation zones sampled at the Parque Natural Municipal de Grumari, state of Rio de Janeiro, southeastern Brazil. CPBZ = Closed post-beach zone; RFZ = "Restinga" forest zone. 1) 23°02'52.01" S, 43°32'00.12" W; 2) 23°02'56.33" S, 43°31'58.48" W; 3) 23°02'47.85" S, 43°31'19.40" W; 4) 23°02'51.88" S, 43°31'18.77" W. Satellite image modified from Google Earth. Maps by GRW.

Figure 2. Sampled areas at the "restinga" of Parque Natural Municipal de Grumari, state of Rio de Janeiro, southeastern Brazil. A = Pond; B = Leaf-litter; C = Swamp. Photos by F.B.S.T.

Results and Discussion

We recorded 22 anuran species at the restinga of PNMG belonging to 13 genera and distributed in six families (number of species per family in parenthesis): Bufonidae (1), Craugastoridae (1), Hylidae (14), Leptodactylidae (3), Microhylidae (2) and Strabomantidae (1) (Table 1; Figures 3-8).

Previous records mentioned the occurrence of only six anuran species for PNMG area. First, four frog species were reported (*Dendropsophus decipiens*, *Phyllomedusa rohdei*, *Itapotihyla langsdorffii* and *Stereocyclops parkeri*) (Izecksohn and Carvalho-e-Silva 2001), and after, based on two nights of sampling, two additional frog species were recorded (*Leptodactylus latrans* and *Aparasphenodon brunoi*) (Rocha *et al.* 2008). All of them were also found during the present study, which recorded 16 additional species.

The microhylid *Chiasmocleis carvalhoi* (Figure 5) is present in the IUCN Red List of Threatened Species under the "Endangered" (EN) category, and it is believed to have a restricted (smaller than 500 km^2) and highly fragmented distribution (Pimenta and Peixoto 2004). This species occurs in the restinga of PNMG, and the maintenance of it as a protected area is a significant contribution to protect this threatened species. Also, according to IUCN, the hylid frogs *Itapotihyla langsdorffii* (Figure 6) and *Aparasphenodon brunoi* (Figure 7), and the endemic leaf litter frog *Euparkerella brasiliensis* (Figure 8) are listed as "Least Concern" (LC) but with their populations under a decreasing trend, mainly because environmental

fragmentation and destruction of habitats in which they occur (Aquino *et al.* 2004; Carvalho-e-Silva and Telles 2004; Rocha *et al*. 2004b). The presence of bromelicolous frogs (*e.g. Aparasphenodon brunoi*, *Scinax cuspidatus*, *Trachycephalus nigromaculatus*) living associated to local bromeliad species (Rocha *et al.* 2004a) in the restinga of Grumari is also indicative of the considerable conservation value of the area.

The importance of Grumari may also be verified through its comparison to other studied sites. On a review on anuran fauna in restinga habitats from Bahia to Santa Catarina States, Carvalho-e-Silva *et al.* (2000) reported 52 species. At Grumari, we found 22 species, corresponding to over 40% of the amphibian species listed on that review for this large extension of Brazilian coast. Bastazini *et al.* (2007) recorded 30 amphibian species in "restinga" areas at the municipality of Mata de São João (State of Bahia) while Rocha *et al.* (2008) reported that the richest locality among 10 "restinga" areas studied along the States of Rio de Janeiro, Espírito Santo and Bahia was Praia das Neves (State of Espírito Santo), with 13 species. Van Sluys *et al.* (2004) recorded nine anuran species at Parque Nacional de Jurubatiba (State of Rio de Janeiro), Narvaes *et al.* (2009) listed 20 species for the "restinga" forest of Estação Ecológica Juréia-Itatins (State of São Paulo), and Bertoluci *et al.* (2007) found 17 species at the "restinga" of Ilha do Cardoso (State of São Paulo). The restinga area nearest to Grumari that have available data on its anuran fauna is Marambaia (44 km to the west), and 12 species of frogs were reported for that area (Silva *et al*. 2008) (Table 2). Additionally, 15 anuran species were recorded in Baixada do Maciambu (state of Santa Catarina) (Wachlevski and Rocha 2011) (Table 2). Differences in the formation history of restingas and in their flora and vegetation structure (Araújo *et al.* 1998), together with dissimilar methodologies, sampling effort and sampling time among the different studies may explain part of the differences in species richness and composition of anuran fauna among these areas. Nevertheless, Hylidae is the most speciose family at PNMG, according to what has been observed for the Atlantic Rainforest biome as a whole (Heyer *et al.* 1990; Izecksohn and Carvalho-e-Silva 2001; Pombal and Gordo 2004; Salles *et al.* 2009), and for "restinga" habitats in particular (Carvalho-e-Silva *et al.* 2000; Van Sluys *et al.* 2004; Rocha *et al.* 2008; Wachlevski and Rocha 2011).

Our results reinforce the importance of long term surveys and evidence the area as a singular refuge for the anuran fauna of restinga habitats in the state of Rio de Janeiro. The restinga of Grumari also houses a population of the endemic, and endangered, sand lizard *Liolaemus lutzae* (Rocha *et al.* 2009) and a new currently not described species of amphisbaenian that is so far known only from this locality (Rocha *et al.* 2003). Long-term studies with other faunal groups in this area are also needed.

Table 1. Anuran species surveyed at the restinga of Parque Natural Municipal de Grumari, Rio de Janeiro, Brazil, and the microhabitat in which they were found on its first assessment. Lt=Leaf-litter; Br=Bromeliads; Tr=Trees/Bushes; Vw=Vegetation on water; Ep=Edge of pond; Sw=Swamp. * Visual and acoustic records; ** acoustic record only; ▲ Occasional encounters only.

FAMILY/SPECIES	Lt	Br	Tr	Vw	Ep	Sw
Bufonidae Gray, 1825						
Rhinella ornata (Spix, 1824)	X	-	-	-	-	-
Craugastoridae Hedges, Duellman and Heinicke, 2008						
Haddadus binotatus (Spix, 1824)	X	-	-	-	-	-
Hylidae Rafinesque, 1815						
Aparasphenodon brunoi Miranda-Ribeiro, 1920	-	X	X	-	-	-
Dendropsophus anceps (Lutz, 1929) *▲	-	-	X	X	-	-
Dendropsophus bipunctatus (Spix, 1824) *	-	-	-	X	-	-
Dendropsophus decipiens (A. Lutz, 1925) ▲	-	-	X	-	-	-
Dendropsophus elegans (Wied-Neuwied, 1821)	-	-	-	X	-	-
Hypsiboas albomarginatus (Spix, 1824) *	-	-	X	X	X	-
Hypsiboas faber (Wied-Neuwied, 1821) **	-	-	-	-	-	-
Itapotihyla langsdorffii (Duméril and Bibron, 1841) ▲	-	X	X	-	X	-
Phyllomedusa rohdei Mertens, 1926	X	X	X	X	-	-
Scinax argyreornatus (Miranda-Ribeiro, 1926) *	X	X	X	X	X	-
Scinax cuspidatus (A. Lutz, 1925)*	-	-	-	X	X	-
Scinax similis (Cochran, 1952)	X	-	-	-	-	-
Scinax aff. *x-signatus*	X	-	-	-	-	-
Trachycephalus nigromaculatus Tschudi, 1838 ▲	-	-	X	-	-	-
Leptodactylidae Werner, 1896						
Leptodactylus latrans (Linnaeus, 1758)	X	-	-	-	-	X
Leptodactylus marmoratus (Steindachner, 1867) *	X	-	-	-	-	-
Leptodactylus spixi Heyer, 1983	X	-	-	-	-	-
Microhylidae Günther, 1858						
Chiasmocleis carvalhoi Cruz, Caramaschi and Izecksohn, 1997	X	-	-	-	-	-
Stereocyclops parkeri (Wettstein, 1934)	X	-	-	-	-	-
Strabomantidae Hedges, Duellman and Heinicke, 2008						
Euparkerella brasiliensis (Parker, 1926)	X	-	-	-	-	-

Table 2. Amphibian richness, time sampled, and localities of the restinga areas studied to date. BA=Bahia; ES= Espírito Santo; RJ=Rio de Janeiro; SP=São Paulo; SC = Santa Catarina.

LOCALITIES	STATE	TIME SAMPLED	SPECIES RICHNESS	REFERENCES
Mata de São João	BA	1 year	30	Bastazini *et al.* 2007
Praia das Neves	ES	> 1 year	13	Rocha *et al.* 2008
Parque Nacional de Jurubatiba	RJ	2 years	09	Van Sluys *et al.* 2004
Grumari	RJ	> 1 year	22	Present study
Marambaia	RJ	6 years	12	Silva *et al.* 2008
Ilha do Cardoso	SP	1 year	17	Bertoluci *et al.* 2007
Estação Ecológica Juréia-Itatins	SP	> 1 year	20	Narvaes *et al.* 2009
Baixada do Maciambu	SC	> 2 years	15	Wachlevsky and Rocha 2010

Figure 3. Anurans from the "restinga" of Parque Natural Municipal de Grumari, Rio de Janeiro state, southeastern Brazil. A = *Rhinella ornata*; B = *Haddadus binotatus*; C = *Dendropsophus anceps**; D = *Dendropsophus bipunctatus**; E = *Dendropsophus elegans**; F = *Hypsiboas albomarginatus*. Photos by F.B.S.T. *Voucher specimens.

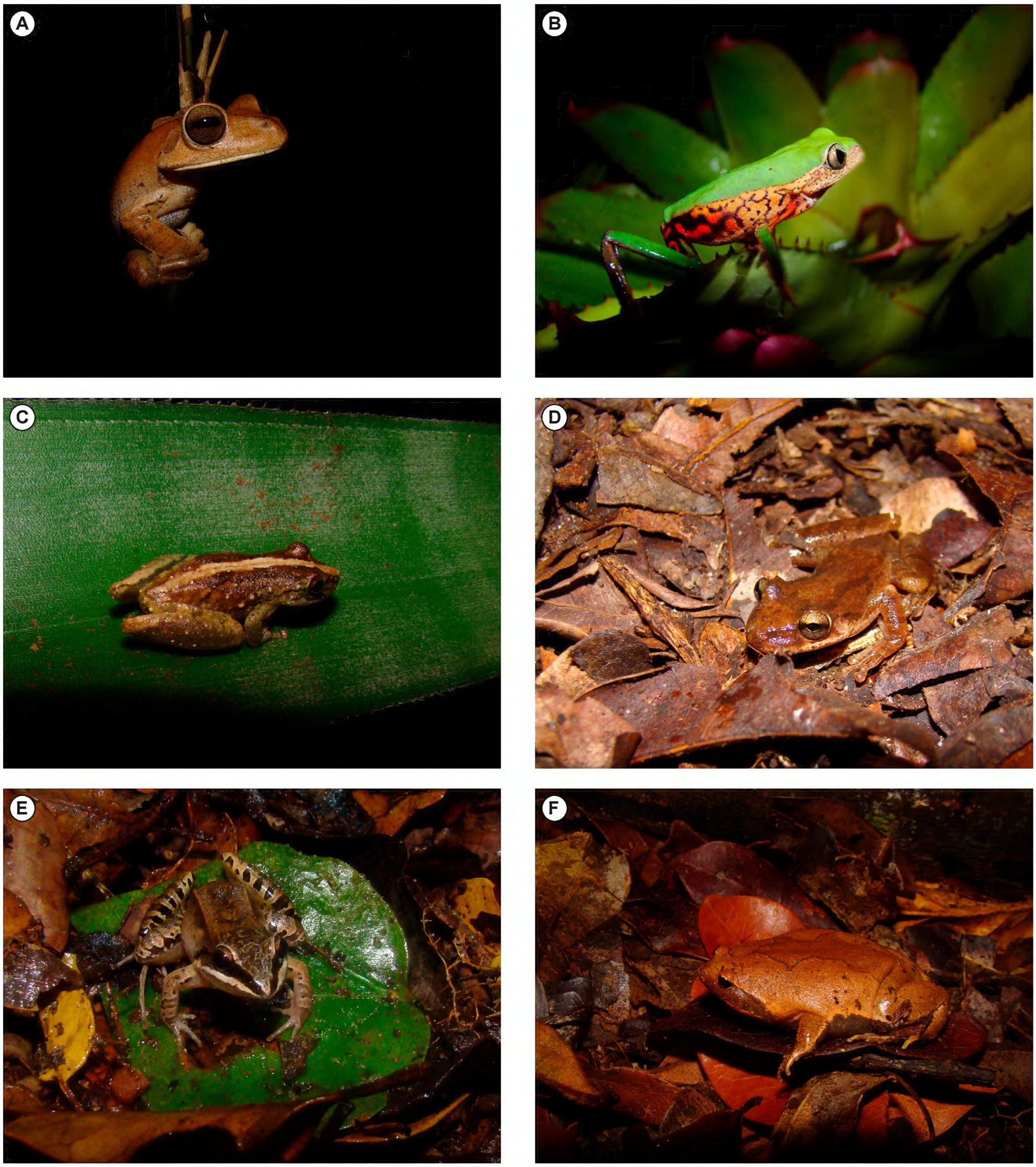

FIGURE 4. Anurans from the "restinga" of Parque Natural Municipal de Grumari, Rio de Janeiro state, southeastern Brazil. A = *Hypsiboas faber*; B = *Phyllomedusa rohdei**; C = *Scinax argyreornatus*; D = *Scinax* aff. *x-signatus**; E = *Leptodactylus latrans*; F = *Stereocyclops parkeri*. Photos by F.B.S.T. *Voucher specimens.

Figure 5. Species with some concern on their conservation status (sensu IUCN, 2011) occurring at the "restinga" of Parque Natural Municipal de Grumari, state of Rio de Janeiro, southeastern Brazil. A = *Chiasmocleis carvalhoi** (Endangered); B = *Itapotihyla langsdorffii**; C = *Aparasphenodon brunoi*; D = *Euparkerella brasiliensis* (Least Concern, with populations in a decreasing trend). Photos by F.B.S.T. *Voucher specimens.

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Appendix 1. Voucher specimens for amphibian species from restinga of Parque Natural Muncipal de Grumari, Rio de Janeiro.

Bufonidae: *Rhinella ornata* (MNRJ 71534); **Craugastoridae:** *Haddadus binotatus* (MNRJ 71518); **Hylidae:** *Aparasphenodon brunoi* (MNRJ 58063), *Dendropsophus anceps* (MNRJ 71514), *Dendropsophus bipunctatus* (MNRJ 71585), *Dendropsophus decipiens* (MNRJ 71536), *Dendropsophus elegans* (MNRJ 71517), *Hypsiboas albomarginatus* (MNRJ 71515), *Itapotihyla langsdorffii* (MNRJ 71531), *Phyllomedusa rohdei* (MNRJ 71519), *Scinax argyreornatus* (MNRJ 71583), *Scinax cuspidatus* (MNRJ 71582), *Scinax similis* (MNRJ 71530), *Scinax* aff. *x-signatus* (MNRJ 71533), *Trachycephalus nigromaculatus* (MNRJ 71537); **Leptodactylidae:** *Leptodactylus latrans* (MNRJ 71516), *Leptodactylus marmoratus* (MNRJ 71634), *Leptodactylus spixi* (MNRJ 71535); **Microhylidae:** *Chiasmocleis carvalhoi* (MNRJ 71584), *Stereocyclops parkeri* (MNRJ 58094); **Strabomantidae:** *Euparkerella brasiliensis* (MNRJ 71531).

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LISTS OF SPECIES

Anurans from the "Restinga" of Parque Natural Municipal de Grumari, state of Rio de Janeiro, southeastern Brazil

Felipe Bottona da Silva Telles*, Vanderlaine Amaral Menezes, Thiago Maia-Carneiro, Thiago Arnt Dorigo, Gisele Regina Winck and Carlos Frederico Duarte Rocha

Universidade do Estado do Rio de Janeiro, Instituto de Biologia Roberto Alcântara Gomes, Departamento de Ecologia, Programa de Pós-Graduação em Ecologia e Evolução. Rua São Francisco Xavier 524, pavilhão Haroldo Lisboa, sala 220. CEP 20550-019. Rio de Janeiro, RJ, Brazil.
* Corresponding author. E-mail: *felipebottona@uerj.br*

ERRATUM

In page 1271, Figure 4E was erroneously labeled as *Leptodactylus latrans*. The figured specimen actually is a *Leptodactylus spixi* Heyer, 1983.

The authors,

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